APPARATUS AND METHOD FOR CATEGORIZING SERVICES USING CANONICAL SERVICE DESCRIPTIONS
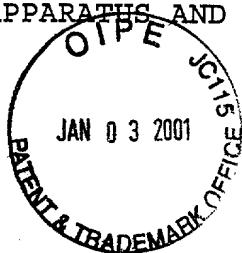
RELATED APPLICATIONS

This application is related to similar subject matter as co-pending and commonly assigned U.S. Patent Application Serial Nos. _____ (Attorney Docket No. RSW9-2000-0101) entitled "APPARATUS AND METHOD FOR E-BUSINESS SERVICE BROKERAGE", filed _____, _____ (Attorney Docket No. RSW9-2000-103) entitled "APPARATUS AND METHOD FOR VERIFYING CATEGORIZATION OF SERVICES USING CANONICAL SERVICE DESCRIPTION TESTS", filed on even date herewith, and _____ (Attorney Docket No. RSW9-2000-104) entitled "SERVICE TAXONOMY CRAWLER APPARATUS AND METHOD", filed on even date herewith, each of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention is directed to an apparatus and method for categorizing services using canonical service descriptions. More specifically, the present invention is directed to an apparatus and method for electronic business (e-business) service categorization for use with an electronic service broker in order to place e-business services into categories within taxonomies that are searchable at run time.

2. Description of Related Art:

A world in which a myriad of e-business services connect and collaborate with one another over the Internet is fast becoming a reality. Business-to-business (B2B) service interactions already

exist using a variety of schemes that range from very rigid
point-to-point Electronic Data Interchange (EDI) interactions to
open Web auctions, e.g., Ariba, Chemdex, eSteel, and eBay.
Thousands of businesses have already made some of their IT
5   services available to their customers or partners on the Web.
Most of these services are intended for use from a browser. But
with technology such as WIDL from webMethods
(www.webmethods.com), many of the Web-enabled services can also
participate in B2B collaborations.

10   Known e-business services collaborate without any
overarching vision or architecture. Techniques for B2B
collaboration vary from one case to another. As the number and
type of e-business services grows, the ability of an e-business
consumer to locate and contact a provider of an e-business
15   service will become increasingly difficult. Today, there is no
vendor neutral archtectural mechanism for classifying e-business
services such that an e-business service consumer can locate and
contact a provider of a desired e-business service. Thus, it
would be beneficial to have an apparatus and method for
20   classifying services in such a manner as to make them searchable
and usable at run-time.

SUMMARY OF THE INVENTION

5 The present invention provides an apparatus and method for service classification. The present invention makes use of canonical service descriptions which designate minimum requirements for a service to be classified into a corresponding classification. Based on the canonical service description, it

10 can be determined whether a service that wishes to be classified into a particular classification of a taxonomy on a service broker meets the minimum requirements, in terms of functionality and application program interface (API), for example, for that classification. Furthermore, the use of canonical service

15 descriptions ensures that all services classified into a particular classification have a minimum level of functionality that will allow them to function properly when invoked.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a diagram illustrating a distributed data processing system according to the present invention;

Figure 2 is an exemplary block diagram of a server according to the present invention;

Figure 3 is an exemplary block diagram of a client according to the present invention;

Figure 4 is an exemplary block diagram illustrating the interaction of e-business service consumers with e-business service providers via a broker;

Figure 5 is an exemplary diagram illustrating a canonical service description in accordance with the present invention;

Figure 6 is an exemplary diagram illustrating the registration of a service in multiple taxonomies of various service brokers;

Figure 7 is an exemplary diagram illustrating the hierarchical levels traversed in a service broker to identify an e-business service provider in accordance with the present invention;

Figure 8 is a flowchart outlining an exemplary operation of the present invention when registering a new service with a broker; and

Figure 9 is a flowchart outlining an exemplary operation of the present invention when identifying an e-business service provider based on the categorization of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference now to the figures, and in particular with reference to **Figure 1**, a pictorial representation of a

5   distributed data processing system is depicted in which the present invention may be implemented. Distributed data processing system **100** is a network of computers in which the present invention may be implemented. Distributed data processing system **100** contains network **102**, which is the medium

10   used to provide communications links between various devices and computers connected within distributed data processing system **100**. Network **102** may include permanent connections, such as wire or fiber optic cables, or temporary connections made through telephone connections.

15   In the depicted example, server **104** is connected to network **102**, along with storage unit **106**. In addition, clients **108**, **110** and **112** are also connected to network **102**. These clients, **108**, **110** and **112**, may be any type of computing device capable of sending and/or receiving information via the network **102**. For

20   example, the clients may be personal computers, network computers, personal digital assistants, Internet capable cellular telephones, and the like. For purposes of this application, a network computer is any computer coupled to a network which receives a program or other application from another computer

25   coupled to the network. In the depicted example, server **104** provides data, such as boot files, operating system images and applications, to clients **108-112**. Clients **108**, **110** and **112** are clients to server **104**. Distributed data processing system **100** may include additional servers, clients, and other devices not

30   shown.

In the depicted example, distributed data processing system

100 is the Internet, with network **102** representing a worldwide collection of networks and gateways that use the TCP/IP suite of protocols to communicate with one another. At the heart of the Internet is a backbone of high-speed data communication lines between major nodes or host computers consisting of thousands of commercial, government, education, and other computer systems that route data and messages. Of course, distributed data processing system **100** also may be implemented as a number of different types of networks such as, for example, an intranet or a local area network. **Figure 1** is intended as an example and not as an architectural limitation for the processes of the present invention.

Referring to **Figure 2**, a block diagram of a data processing system which may be implemented as a server, such as server **104** in **Figure 1**, is depicted in accordance with the present invention. Data processing system **200** may be a symmetric multiprocessor (SMP) system including a plurality of processors **202** and **204** connected to system bus **206**. Alternatively, a single processor system may be employed. Also connected to system bus **206** is memory controller/cache **208**, which provides an interface to local memory **209**. I/O bus bridge **210** is connected to system bus **206** and provides an interface to I/O bus **212**. Memory controller/cache **208** and I/O bus bridge **210** may be integrated as depicted. Peripheral component interconnect (PCI) bus bridge **214** connected to I/O bus **212** provides an interface to PCI local bus **216**. A number of modems **218-220** may be connected to PCI bus **216**. Typical PCI bus implementations will support four PCI expansion slots or add-in connectors. Communications links to network computers **108-112** in **Figure 1** may be provided through modem **218** and network adapter **220** connected to PCI local bus **216** through add-in boards. Additional PCI bus bridges **222** and **224** provide

interfaces for additional PCI buses **226** and **228**, from which

additional modems or network adapters may be supported. In this

manner, server **200** allows connections to multiple network

computers. A memory mapped graphics adapter **230** and hard disk

5   **232** may also be connected to I/O bus **212** as depicted, either

directly or indirectly.

Those of ordinary skill in the art will appreciate that the

hardware depicted in **Figure** 2 may vary. For example, other

peripheral devices, such as optical disk drives and the like,

10   also may be used in addition to or in place of the hardware

depicted. The depicted example is not meant to imply

architectural limitations with respect to the present invention.

The data processing system depicted in **Figure** 2 may be, for

example, an IBM RISC/System 6000, a product of International

15   Business Machines Corporation in Armonk, New York, running the

Advanced Interactive Executive (AIX) operating system.

With reference now to **Figure** 3, a block diagram of a data

processing system in which the present invention may be

implemented is illustrated. Data processing system **300** is an

20   example of a client computer. Data processing system **300** employs

a peripheral component interconnect (PCI) local bus architecture.

Although the depicted example employs a PCI bus, other bus

architectures, such as Micro Channel and ISA, may be used.

Processor **302** and main memory **304** are connected to PCI local

25   bus **306** through PCI bridge **308**. PCI bridge **308** may also include

an integrated memory controller and cache memory for processor

302. Additional connections to PCI local bus **306** may be made

through direct component interconnection or through add-in

boards. In the depicted example, local area network (LAN)

30   adapter **310**, SCSI host bus adapter **312**, and expansion bus

interface **314** are connected to PCI local bus **306** by direct

component connection.

In contrast, audio adapter **316**, graphics adapter **318**, and audio/video adapter (A/V) **319** are connected to PCI local bus **306** by add-in boards inserted into expansion slots. Expansion bus
5   interface **314** provides a connection for a keyboard and mouse adapter **320**, modem **322**, and additional memory **324**.

In the depicted example, SCSI host bus adapter **312** provides a connection for hard disk drive **326**, tape drive **328**, CD-ROM drive **330**, and digital video disc read only memory drive (DVD-
10   ROM) **332**. Typical PCI local bus implementations will support three or four PCI expansion slots or add-in connectors.

An operating system runs on processor **302** and is used to coordinate and provide control of various components within data processing system **300** in **Figure** 3. The operating system may be a
15   commercially available operating system, such as Linux, which is available from International Business Machines Corporation. An object oriented programming system, such as Java (a trademark of Sun Corporation), may run in conjunction with the operating system, providing calls to the operating system from Java
20   programs or applications executing on data processing system **300**. Instructions for the operating system, the object-oriented operating system, and applications or programs are located on a storage device, such as hard disk drive **326**, and may be loaded into main memory **304** for execution by processor **302**.
25   Those of ordinary skill in the art will appreciate that the hardware in **Figure** 3 may vary depending on the implementation. For example, other peripheral devices, such as optical disk drives and the like, may be used in addition to or in place of the hardware depicted in **Figure** 3. The depicted example is not
30   meant to imply architectural limitations with respect to the present invention. For example, the processes of the present

invention may be applied to multiprocessor data processing systems.

The present invention provides an apparatus and method for categorizing services, e.g., e-business services, such that the categories of services may be searched to identify a supplier of a desired service. Based on the categorization of services, brokers may be established for providing a brokerage service to identify service providers.

With the present invention, a service provider may register with one or more brokers to thereby publicize the availability of their services. When a service consumer wishes to make use of a service, the consumer contacts a broker, provides the criteria of the service desired, and instructs the broker to find a compatible provider of the desired service. The broker may then provide the service consumer with information indicating how to contact the service provider.

Figure 4 is an exemplary block diagram illustrating the interaction of service consumers with service providers via a broker in accordance with the present invention. With the present invention, service consumer **410** is a requester of services, server providers **430-450** are suppliers of services, and broker **420** facilitates service consumers identifying compatible service providers.

The service consumer **410** may be any type of device that makes use of services available via the network **102**. For example, the service consumer **410** may be a client device, such as client devices **108-112** in **Figure 1**.

The description of the present invention refers to "services" which are requested by service consumers and supplied by service providers. The term "services" means any service that satisfies a business agenda of the service consumer. The "service" may collaborate with applications and services of other

consumers, providers, and organizations. A service may be, for

example, credit card authorization, credit report ranking,

printing a document, applying postage to the document, and any

other service that may be provided or contracted for via a

5   network.

The service consumer **410** sends requests for services to the

broker **420** via the network **102**. The request is properly

formatted so that the broker **420** may determine the category of

service which is being requested by the service consumer **410**.

10   Based on the request and request parameters, the broker **420**

identifies one or more service providers that satisfy the

request, if any compatible service providers are registered with

the broker **420**, in a manner described hereafter. The service

consumer may then select a service provider from those identified

15   and obtain, from the broker **420**, information identifying the

manner by which the service consumer may contact and obtain the

requested service from the service provider.

The service providers **430-450** may be implemented as any

device coupled to the network **102** that is capable of providing or

20   contracting for a service based on requests received over the

network **102**. The broker **420** is any type of device that is

capable of receiving service requests from a service consumer

410, identify a service provider that provides the requested

service, and provides contact information to the service consumer

25   via the network **102**. The service providers **430-450** and the

broker **420** may be implemented, for example, in a server

apparatus, such as server **104**.

In order to maximize the benefit of services offered via a

large and varying network environment, such as the Internet, a

30   unified organizing principle must be adopted by which service

consumers may be made aware of services that are available and

the providers of these services. The present invention provides an architecture by which services may be categorized in such a manner as to facilitate informing consumers of the availability of services and their providers.

Categorization according to the present invention makes use of one or more taxonomies created and supported by each broker. The taxonomies are hierarchical in nature to reflect commonalties larger than the individual species. Just as with biological taxonomies, there is more than one way to categorize species of services and hence, there may be more than one possible taxonomy into which a service is classifiable. Because there may be many different possible taxonomies into which a service may be classified, a service provider may need to register its services with multiple brokers, each broker supporting a different taxonomy into which the service may be classified.

The service provider decides, at registration time, in which category, or categories, the service is to be registered. For example, if the service is air conditioning repair, the service provider may decide to register the service in a category of a taxonomy identified by home>repair>airconditioning or household>equipment>airconditioning>repair, or the like.

Each category of a taxonomy must define the semantics, i.e. what the services in the category do, as well as the application program interface (API) used to communicate with the service providers, i.e. how to invoke the services. In order to provide such classifications, a canonical service description (CSD) may be used to describe each classification. The CSD provides a mechanism by which a service may be classified that is recognizable by all parties to the service brokerage transaction. That is, the CSD based classification is recognized by the service consumer, the broker, and the service providers.

All services in a category must implement the canonical

service description for that category, although they may do more than is provided in the CSD, i.e. the CSD provides the minimum requirements for a service to be classified into a corresponding category.

5   The use of CSDs that define the minimum requirements for services in a category provides a mechanism that facilitates searching of taxonomies at runtime. At runtime there is little, if any, interaction with a human user. Thus, in order to perform searching of categories in a taxonomy to identify services, a

10   mechanism is needed by which to perform the search. This mechanism is the CSD.

          With the present invention, an automatic search of the categories in a taxonomy is possible by searching for a matching CSD, i.e. a CSD that matches a requested CSD or provides minimum

15   requirements corresponding to requirements of a search query. Such a search does not require input from a human user at runtime because each service categorized into a particular category is guaranteed to implement at least the functionality and APIs designated by the CSD of that category.

20   **Figure 5** illustrates an exemplary canonical service description. The canonical service description shown in **Figure 5** is provided in the extensible markup language (XML) and represents an example canonical service description for a stock quote service. The mechanism used for describing the canonical

25   service description is the web services description language (WSDL), with CSD related extensions. The use of WSDL is standard, defining the "reusable" portion of a web service over the Simple Object Access Protocol (SOAP).

          There are two main elements in the file that distinguish

30   this file as a CSD description from other uses of WSDL to define "reusable" portions of a service description. These two elements are both defined within the CSD namespace extension to the WSDL

language. CSD-related elements are inserted into a WSDL using
the standard extension mechanism defined in the WSDL language.

The example shown in **Figure 5** defines a StockQuoteBinding
CSD, for use in defining the standard web services interface
definition for stock quoting. Organizations may use this CSD as
the template for defining "API standard" stock quote web
services.

The csd:testService element defines the specific service
information of a service that provides validatable results. If a
developer wishes to test an implementation of the stock quote web
service, as will be discussed in greater detail hereafter, the
developer may invoke the web service implementing the
stockQuoteBinding and compare the results of this service by
invoking the canonical test service for the CSD identified by the
service definition described in the csd:testService element.

The csd:categorization element defines the category(s) in
the taxonomy(s) in which implementations of the CSD should be
placed. In this case, web services implementing this CSD are
eligible to be inserted into the equityInstruments taxonomy,
defined by the financialWebServicesStandards organization, and
into the category equityInstruments>equities>quotes>
nonRealTimeQuotes.

The CSD shown in **Figure 5** is for illustration purposes only
and is not intended to be limiting in any way. CSDs in
accordance with the present invention may include other
information in addition to, or in replacement of, the information
shown in **Figure 5** without departing from the spirit and scope of
the present invention.

The CSD provides a description of the service that is
provided in such a manner as to be cognizable to the service
consumer. The CSD includes service descriptions that are both
human readable and machine parsable. For example, the CSD

service descriptions may be implemented in the extensible markup
language (XML) which is parsable by machines, a word processor
formatted document, or the like. The CSDs also describe non-
functional requirements, such as security and authentication
assumptions, and other prerequisites considered to be common to
all services in the category.

The CSD for each category is related to that of the category
one level up. However, the semantics of a given service may
differ from the next level up in important ways. That is, a
specialization of a service at the next level down in the
hierarchy may implement the same function, but do so in a very
different way with different argument characteristics and
different returned results from that of the next level up. Thus,
the CSD describes how the services in the category differ from
those in a parent category and any sibling categories in the
taxonomy.

The CSDs may provide tests by which membership in the
category may be determined. These tests may be provided as
executable tests in XML, or other similar executable languages,
for example. That is, when a service provider attempts to
register its service with a broker, the broker may determine
whether or not the service meets the minimum requirements of a
chosen category based on the tests included in the corresponding
CSD. The CSD tests allow a broker to objectively and
automatically determine that a service satisfies the requirements
for being included in a particular category.

The CSD test identifies messages that may be sent to the
service provider and corresponding reply message that should be
received from the service provider. These messages may be
directed to various aspects of the service that is provided by
the service provider. For example, these messages may be
directed to security issues, privacy issues, and communication

protocols used by the service.

When a service provider requests to have their service registered in a particular category of a taxonomy supported by a service broker, the service provider sends a request to the service broker identifying the category that the service is intending to be registered in as well as the APIs used by the service. The API description may include, for example, method names, parameter names, parameter types, executable API test suites, and the like, such that the service broker can determine whether the service implements what it claims to implement before registering it in a given category.

Upon receiving the registration request from the service provider, the service broker performs the tests associated with the CSD of the selected category. That is, the service broker sends the messages included in the tests to the service provider and monitors the reply messages received. The sending of the messages to the service provider is performed in view of the method name, parameter names, parameter types, etc. Included in the API description of the registration request. The service broker then matches the reply messages received to the "correct" reply messages included in the CSD test. If there is a match of the test messages, the service is verified as meeting the requirements of the CSD and the service is permitted to be registered in the selected category.

If the service implements exactly the API specified in the category's canonical service description, the service description included with the registration request need not provide any further tests. However, any additional functionality beyond the API specified in the CSD may be accompanied by additional tests. These additional tests are implemented in the same way as the CSD tests to confirm that the service provides the functions identified.

Security constraints on some services may require that the taxonomy server be given special certificates or other certification information as part of registration so that it can execute the tests. In situations that call for extreme security,

5   authentication or encryption, the taxonomy server may only receive exceptions in response to the tests. Even in that case, though, it should receive the correct exceptions, i.e. the exception received should indicate that the service is present but not responding due to inadequate authentication.

10   If a service fails one or more of the tests in the CSD, or additional tests included in the registration request, the service provider may be provided with a report of which tests were satisfied and which tests failed. In this way, the service provider is provided with information by which the operator of

15   the service provider may modify their service description and service functionality to conform to the requirements of the selected category.

Thus, the use of canonical service descriptions provides a mechanism by which services may be categorized and verified to

20   meet the minimum requirements of the particular categories in which they are placed. Thus, if a service is to be registered with multiple taxonomies, the service is guaranteed to meet the minimum requirements of each category in which it is registered.

In order for the brokerage mechanism of the present

25   invention to operate, service providers must first register with one or more brokers in accordance with the taxonomies supported by those brokers. In determining with which brokers to register, the service provider must balance the service consumer's desire to have a "target rich" environment with the need for the service

30   provider to be "seen" in the right places. The balance of these two concerns results in the need for a service provider to examine the taxonomies supported by various brokers and register

the service with those brokers, and in the appropriate
categories, where service consumers are likely to look for the
service.

    As an example to illustrate the need to register with
5   multiple brokers, consider a fictional small retail flower e-
business in Des Moines, Iowa named "CornFlowers.com," as shown in
Figure 6. In addition to the general flower retailing business,
CornFlowers.com specializes in growing and selling a number of
varieties of orchids.

10   CornFlowers.com participates as a buyer in at least two B2B
e-business markets. It buys most of its standard types of
flowers over a B2B link with its primary wholesaler and it buys
specialty items (e.g., accessories, balloons, vases and planters)
from a florist supplies broker.

15   CornFlowers.com also wishes to provide flower selling e-
business services to clients via the Internet. CornFlowers.com
participates as a supplier in two industry-oriented brokers
(FTD.com's industry broker and 5Flowers.com's industry broker).
CornFlowers.com also wants to provide flower selling e-business
20   services to other clients outside of the "big" flower brands
(FTD, 5FLOWERS). As a result, CornFlowers.com wants to appear in
flower-related e-marketplaces (e.g., for weddings and funerals)
in the Des Moines area. CornFlowers.com is also active in
Orchids of America, a special interest group concerned with the
25   growing and marketing of orchids. It is in CornFlower.com's
business interest to be visible as a provider of B2B services in
this group as well.

    Note that CornFlower.com's business success depends upon
being listed in appropriate, but different, categories in several
30   taxonomies supported by several different brokers.
CornFlower.com wishes to be listed geographically in FTD and
5FLOWERs. It wishes to be listed by flowers in the Des Moines

broker, and wishes to be listed by its specialized orchid varieties in the orchid broker. As a result, CornFlower.com registers its service in the flowers.FTD.com>Retail>USA>IOWA>Des Moines category of the taxonomy supported by the FTD broker, the

5   localYellowPages.org>Florists>DownTown category in the taxonomy supported by the "AllThingsDesMoines" services yellow pages broker, and the OOA.org>Retail>Midwest>Iowa category in the Orchids of America broker.

       In registering its service with a broker, the service

10   provider submits a registration request to the broker. The registration request includes a service description, an API designation, and any other non-functional information pertinent to the invoking of the service. The API designation and non-functional information may be designated in terms of a model

15   description. The model description identifies the address by which to contact the service provider, the protocols used to communicate with the service provider, security used by the service provider, authentication and privacy, as well as any other non-functional information.

20   The registration request further includes an indication of the categories within the taxonomies of the broker in which the described service may be categorized.

       The determination whether to allow the registration in the requested categories may be made based on minimum requirements of

25   the category, as designated by the corresponding canonical service description, in order to make sure the service to be registered is in conformance with other services already registered under the categories. These minimum requirements may include, for example, security issues, privacy issues,

0   communication protocols, and the like, which are designated in a CSD.

       The determination of whether or not the service to be

registered meets the minimum requirements may be made by a human
administrator of the service broker or automatically by the
service broker itself based on canonical service description
tests, as described above. If a service to be registered is

5 identified as meeting the CSD requirements of a particular
category, the service may be registered under that category. If
the service to be registered is identified as meeting the CSD
requirements of more than one category, the service provider may
be provided with the option to register under one or more of the

10 categories.

If a service to be registered is not identified as meeting
the requirements of any category in the supported taxonomy, the
service provider may be provided with the option to request that
the service broker define a new category in which the service may

15 be classified. The administrator of the service broker may then
decide whether or not to support the new classification and
inform the service provider of the decision. If the
administrator agrees to define a new classification, the service
provider may then register its service with the service broker in

20 a manner described above. Otherwise, the service provider will
be unable to register its service with that particular service
broker.

Once a service is registered with a service broker in the
manner described above, the service is included in the list of

25 services associated with the designated category of the service
broker. By stating that the service is included in the list of
services what is meant is that the service description and model
submitted by the service provider is stored in memory in
association with the categories in which the service was

30 registered.

The service consumer may invoke a requested service by first
contacting a service broker to identify a provider of the

service, obtain the model description for the service provider,
and then contact the service provider based on the model
description to thereby obtain the requested service.   In
contacting the service broker, the service consumer sends a

5   request for a service to the service broker.   The service
consumer may be associated with the service broker such that the
request is directed specifically at the service broker, or the
service request may be broadcast across the network **102** such that
service brokers having registered service providers meeting the

10   requirements of the service request may respond accordingly.

       The service request uses the same service description
semantics used by the service providers when submitting their
services to the service brokers for registration.   The service
request is parsable by the service broker to thereby identify the

15   categories in the supported taxonomy that may have registered
services meeting the service request requirements.   For example,
the service request may include an identification of a
taxonomy/category pair that is requested or may include a CSD
description of a service requested.

20   When the service broker receives the service request, the
service broker traverses the supported taxonomy to identify one
or more service providers that may provide the requested service.
For example, if a taxonomy/category pair is identified in the
service request, only those services categorized into the

25   identified category are investigated to determine if they match
the requested service.   Alternatively, if only a CSD description
is provided, the entire taxonomy must be traversed to identify a
service having the requested CSD.

       Figure 7 is an exemplary diagram illustrating the

30   hierarchical levels traversed in a service broker to identify an
e-business service provider in accordance with the present
invention.   As shown in **Figure 7**, a service broker **710** hosts a

taxonomy registry **720**. The taxonomy registry **720** identifies the various 1...n taxonomies supported by the service broker **710**. The root node **730** represents the root of the 0...n categories **740** within the taxonomy. Each category **740** contains 0...n service

5   descriptions **750** identifying registered services in that category. The service descriptions **750** have associated model descriptions **760**. The model descriptions **760** provide the necessary information for contacting a service provider **770**.

       Thus, when searching registered services on a service broker

10   **710**, the service broker traverses each taxonomy corresponding to the taxonomy root nodes **730** in the taxonomy registry **720** and identifies a category **740** meeting the criteria of the service request. Alternatively, this crawling of the taxonomy may be based on an identified taxonomy/category pair in the service

15   request received. The service broker **710** then identifies one or more service providers that provide the requested service based on the registered service descriptions **750** within the identified category **740**. Alternatively, if non-uniform accepted service descriptions are used, the service broker **710** may return all

20   service descriptions registered under a compatible category. The associated model description **760** may then be used by the service consumer to contact the service provider **770**.

       It is possible that there may be a plurality of registered services that meet the requirements of the service request. In

25   such an instance, one of the compatible services may be chosen in either a specified or arbitrary way. For example, the service consumer may be presented with each of the possible candidates and allowed to select the service provider that it wishes to use. The service providers may be ranked based on prior use of the

30   service providers and thus, a higher ranked service provider may be chosen. Service providers may be selected based upon

priorities assigned to non-functional descriptive information included in either the service description or the model definition. Alternatively, a service provider may be selected randomly. Any mechanism by which one service provider may be chosen from a plurality of compatible service providers may be used without departing from the spirit and scope of the present invention.

As mentioned above, the identification of a service provider capable of providing the desired service may be performed at runtime. At runtime, there is no human judgment available to determine if a service matches a required business need. This is not a problem with the present invention since the taxonomy architecture of the present invention ensures that services in a particular classification will at least satisfy the business needs associated with the corresponding CSD's minimum requirements. Therefore, an automatic identification of a compatible service provider is possible based on the classification scheme of the present invention. No human intervention is required.

Thus, with the present invention, a service broker acts as a mediary between service consumers and service providers. Based on the categorization architecture of the present invention, a service registered with the service broker may be automatically identified based on the criteria in a service request, and corresponding contact information may be provided to the service consumer so that the service consumer may contact the service provider to obtain the desired service.

Figure 8 is a flowchart outlining an exemplary operation of the present invention when registering a new service with a broker. As shown in **Figure 8**, the operation starts with the a registration request being received (step **810**). The registration request includes a service description and model description. A

determination is made as to whether the service should be added
to the registered services under the requested classifications
(step **820**). This determination may include determining if the
service description of the service to be registered satisfies the
minimum requirements of the requested classifications in the
taxonomies supported by the service broker, as identified by
corresponding canonical service descriptions. If the
determination is that the service fits the canonical service
description for the requested classification, the service
description and model description are added to the list of
services associated with the selected classification categories
(step **830**).

If the service description is not to be added to any of the
requested classification categories, the service provider may be
provided with the option to request a new category to be created
(step **840**). If the service provider does not request a new
category, the operation ends. If the service provider does
request a new category, a determination is made as to whether or
not a new category should be added (step **850**). If so, a new
category is generated and added to the supported taxonomy (step
860). If a new category is not to be added, the operation ends.

Figure 9 is a flowchart outlining an exemplary operation of
the present invention when processing a service request from a
service consumer. As shown in **Figure 9**, the operation starts
with receiving a service request from a service consumer (step
910). The request includes a service description of the
requested service. The service description in the service
request is parsed (step **920**) and the taxonomies supported by the
service broker are searched to determine if any registered
services meet the service description in the service request
(step **930**). If not, a "no services available" message is

returned to the service consumer (step **940**). If one or more
services are identified, a determination is then made as to
whether more than one service is identified (step **950**). If so,
one of the services is selected based on one or more selection

5   schemes (step **960**). Thereafter, or if only one service is
identified, the model definition for the identified service is
provided to the service consumer so that the service consumer may
contact the service provider (step **970**). The operation then
ends.

10   Thus, the present invention provides a unified architecture
for classifying services into taxonomies, and categories within
these taxonomies, supported by service brokers in a network. The
unified architecture makes use of canonical service descriptions
for purposes of classification and to assure that services meet a

15 minimum requirement for respectivel categories within the
taxonomies. In addition, the canonical service descriptions may
provide executable tests which may be used to verify a service as
meeting minimum requirements for a classification as well as
provide a mechanism by which compatible classifications may be

20 identified to a service provider.

     Based on this architecture, service consumers may send
service requests to service brokers in order to identify those
service providers that are capable of providing a desired
service. The service brokers may then provide contact

25 information to the service consumer such that the consumer may
contact the service provider to obtain the desired service.

     As a further embodiment of the present invention, the
canonical service description tests describe above may be used as
a mechanism for identifying categories in which a service may be

30 registered. For example, consider the scenario of a service
provider sending a registration request to a service broker
identifying a particular category in which a particular service

is to be registered. If the service fails the CSD tests required
for registration in the selected category, the service broker may
look to other similar categories to determine if the service may
meet the CSD tests of these other similar categories.

5   For example, the service broker may look to sibling, parent
and/or child categories, within a certain range of the selected
category in the taxonomy. The CSD tests associated with these
categories may be applied to the service that is to be registered
and a determination as to whether the service satisfies the

10   minimum requirements of these categories may be made. If the
service does meet the minimum requirements of one or more of
these categories, these categories may be identified to the
service provider so that the service provider may be given the
option to select one of these categories for registration of the

15   service.

          It is important to note that while the present invention has
been described in the context of a fully functioning data
processing system, those of ordinary skill in the art will
appreciate that the processes of the present invention are

20   capable of being distributed in the form of a computer readable
medium of instructions and a variety of forms and that the
present invention applies equally regardless of the particular
type of signal bearing media actually used to carry out the
distribution. Examples of computer readable media include

25   recordable-type media such a floppy disc, a hard disk drive, a
RAM, CD-ROMs, and transmission-type media such as digital and
analog communications links.

          The description of the present invention has been presented
for purposes of illustration and description, and is not intended

30   to be exhaustive or limited to the invention in the form
disclosed. Many modifications and variations will be apparent to
those of ordinary skill in the art. The embodiment was chosen

and described in order to best explain the principles of the
invention, the practical application, and to enable others of
ordinary skill in the art to understand the invention for various
embodiments with various modifications as are suited to the

5   particular use contemplated.